THE DIGITAL LAB

Come with us into tomorrow...

THE UNIVERSITY OF
WARWICK

WMG
Innovative Solutions

UK Prime Minister Gordon Brown said of the Digital Lab:

WMG's work is based on very strong collaboration with industry and provides a prime example of how the knowledge created in our universities can be transferred to make a difference in the real world.

I am delighted that this pioneering facility is being built here at Warwick University where there is such a great history of innovation.

The Digital Lab is the creation of Professor Lord Kumar Bhattacharyya and has been developed with the support of Advantage West Midlands. It is managed and staffed by WMG, the international research and education group at the University of Warwick.

For more information on WMG go to:
wmg.warwick.ac.uk

About the Digital Lab

The following pages give an introduction to some of our areas of expertise. To see how to access that capability and work with us as a large, medium or small company turn to the next page.

Research: The Digital Lab is a multi-disciplinary research centre combining WMG's expertise with that in underpinning sciences including psychology, medicine, computer science and mathematics. Businesses wishing to engage in hi-tech R&D are encouraged to come and discover the potential for cost-effective research at the Lab.

Education: Several of WMG's Masters courses will be delivered in the Lab including e-Business Management and Digital Manufacturing Management. From October 2008 we will deliver a new course in Information Assurance and more new courses will be developed to maximise the effectiveness our research. We can also work with collaborators to develop bespoke courses to exploit our digital research.

Knowledge Transfer: Small and medium sized businesses in the West Midlands region can access some of our expertise and leading-edge technology free of charge. Additionally SMEs with modest R&D budgets will be able to take that assistance further to develop bespoke solutions.

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Opportunities to develop your business

Large Organisations

Key contact: Mark Pickering, Director of Development: **07850 856764 m.i.pickering @warwick. ac.uk**

- Gain competitive advantage: extend your global network, be part of a group of thought leaders, gain unique and early insight into world-leading innovative technologies, identify best practice in many sectors, and lead the exploitation of the applications in your market.
- Raise your share of voice: be more visible, showcase your capability through demonstrators and seminars as this world-class facility hosts international leaders from business, governments and international institutions.
- Multiply your R&D activity: boost your company-specific R&D programmes, collaborate in our research consortia, form strategic partnerships with third parties, and explore new application sectors for products.
- Attract and retain great people: reach some of the brightest masters and doctorate students through project work and internships, guide the development of our education programmes that are renowned for fulfilling the potential of existing and new staff, and for delivering improved business performance.
- Raise the effectiveness of your whole supply chain: take the initiative and encourage and involve your supply chain partners.

Small and Medium Sized Businesses

As a small business you can gain advantage from accessing the Digital Lab SME programme. Our knowledge services are taken directly from the Digital Lab's technologies and include:

Key contact: Mark Swift, Head of SME Programmes : **024 7652 3689 mark.swift @warwick. ac.uk**

- The SME Lab: a dedicated SME environment allowing your business to try out a range of demonstrators and leading edge technologies tailored for SMEs, with independent advice on the right solutions for your business.
- Regular seminars: providing updates on digital technologies and concepts and their current relevance to your business.
- Analysis sessions: to appreciate the special features of your business and identify relevant current and emerging digital technology solutions.
- Strategy discussions: individual workshops to review business opportunities and vulnerabilities brought about by digital technologies.
- In-business R&D: we can work with your business on collaborative research projects.

e-Business

With e-business at the heart of company processes, businesses can make a real difference to their growth rate and profit margins. We also need to consider supply networks and how technology can be used to change whole industries and regions. Internet technology can provide opportunities to make significant change.

The Digital Lab hosts two projects that carry out research and advise on e-business.

In partnership with industry, the regional development agency and over 3,000 members, the National B2B Centre, led by Martin King-Turner, is continually researching the latest e-business solutions and technologies. The resulting knowledge is transferred to small and medium sized businesses in the form of expert advice, training courses and seminars from a high-tech Advice Centre, as well as through online tools and web-based resources.

Since its establishment in 2002 the National B2B Centre has helped thousands of companies embed e-business into their business processes, to improve sales, profits and productivity.

In recognition of its professional e-business advice the centre was the first public sector organisation to be awarded 'Premier Practice' status by the Institute of Business Consulting in 2006.

Dr Jay Bal is exploring the role that e-marketplaces can play in becoming economic hubs for regions and industries.

The West Midlands Collaborative Commerce Marketplace (WMCCM) hosts over 6,100 companies, and helps them find new work, find partners to undertake work, and provides virtual filing cabinets to enable the work at low cost. Other applications include GatewayAsia, a platform to help link UK SMEs with companies in China, India and Malaysia; a student-centred course management platform and a EU FP7 research coordination platform for the European Plastics Industry. The WMCCM work is leading onto building a worldwide platform for SME support, linking capability with opportunities and improved market access.

Research on how countries can exploit the Internet has led to projects with the Commonwealth Secretariat and World Bank in the Seychelles, Fiji, Samoa and Malta in the last few years.

To access National B2B Centre services go to: **www.nb2bc.co.uk**

To access WMCCM services go to: **www.wmccm.co.uk**

e-Security

The e-Security Group is led by Professor Sadie Creese and is growing into an internationally leading force in research, innovation and education in digital information assurance and network security.

We are focused on the potential for high impact results via an understanding of current and future stakeholder needs, seeking to provide significant benefits in the short medium and long term which are both uncompromising in technical standard and relevant.

The team's work includes: blue-skies long-term research with the potential for very high impact outputs driven by anticipation of future stakeholder needs; applied research and development both innovative and technically challenging, working with stakeholders to deliver step changes today and in the near future; providing expertise directly into partner projects; delivery of business focused executive education via existing and future programmes.

The scope of our research and innovation interests are broad including almost every aspect of security in cyberspace, the point of interface with the physical domain, the management of information security, the delivery of information assurance and the socio-political context in which e-Security exists. Leveraging the significant intellectual capital within the wider University the e-Security Group is focused on a holistic approach to solutions, considering technology, enterprise and human factors.

For more information on this work go to: **go.warwick.ac.uk/wmg_esecurity**

The following are examples of research challenges we are currently addressing:

- Securing data assets and preventing leakage
- Consent and revocation controls and personal privacy
- Security in dynamic wireless networks and self-adapting systems
- Trust management
- Tangibility of risk cyberspace
- Visualisation of security postures for non-experts
- High-integrity security testing methodologies
- Internet Threat Exposure Metrics

Alongside our research programmes we conduct vulnerability detection and forensic investigations into various technologies selected for their relevance in today's digital economy.

Experiential Engineering

As we move further into the Digital Age, advanced digital techniques have a greater role to play in the design of the products we use and the environments we live, work and play in. It is important that we don't forget that these new products and environments will always be used and experienced by real people.

For future products and spaces to be most successful, they need to be optimised to suit the subjective and emotional responses of their users. But to capture, understand and convert people's thoughts into a form that is useful for designers and manufacturers is a significant research challenge.

The Experiential Engineering team, led by Professor Paul Jennings, is taking on this challenge: they are a group of researchers who cross traditional academic boundaries, with expertise in engineering, design, physics and psychology.

The team has responsibility for projects covering a broad portfolio of applications - from the optimisation of vehicle sounds – the growl or purr of the engine – to the effect of driver behaviour on fuel economy. They also apply their cross-disciplinary methods to consider the experience of children in hospitals, and the impact of positive sounds in urban spaces.

To find out more about these projects go to: **go.warwick.ac.uk/wmg_experiential**

Of particular interest to them is the use of structured evaluations, where customers or end-users can appraise products or environments, or representations of them, in a controlled and repeatable manner, often using simulation tools. But the way people appraise products in real life can differ from the way they appraise products in structured evaluations. Therefore the team is leading research on the most appropriate levels of representation, context and interactivity for use in particular aspects of decision making.

Digital Innovation

The Digital Lab provides the ideal base for the creation of a globally-focussed team to research, create and exploit new opportunities for and from the age of convergence. The deliverables will be digital media outcomes, explored within specific application domains and exploited to underpin future social, economic, technological and policy development.

The aim is to create an emerging technology cell, led by experienced specialisists in digital media and drawing on science, engineering, technology and medical expertise. It will attract future-focussed individuals who believe in the vision of applying learning from the digital age to the market, whether that is in the social, public or private sector.

The Digital Innovation cell will focus on the collaborative cross-sectoral and cross-disciplinary opportunities created by the age of digital convergence. These sectors will include education (at all levels), health (in hospitals and at home), media (convergence think and do tank) design (for all sectors), manufacturing, marketing, professional/financial services and e-security (privacy and identity).

It will enable companies and public bodies to create effective digital strategies for a new service or product leading to competitive advantage. Wider social benefits will come from the opportunities that the personalised approach of internet-based technologies give to engage with the digitally and socially excluded both locally and globally.

The cell will undertake research, create demonstrators and prototypes, provide development support, hands-on training and an understanding of market opportunities enabled by the convergence of web, mobile and broadcast technologies, and the interactivity this enables in games, health services or e-security. Issues of regional broadcasting, local news and public service content in the digital world will be a central focus and may provide evidence and demonstration of a regional digital media platform in the digital age.

For more information on this work go to: **wmg.warwick.ac.uk** ■

Digital Product Lifecycle Management

Product Lifecycle Management integrates engineering and business strategies creating an environment that manages and tracks products and services from cradle-to-grave. By approaching product design, development, manufacturing and service from an integrated perspective, we can create a platform to build more efficient business and service delivery processes.

The team's research, led by Professor Darek Ceglarek and Dr Eduardo Izquierdo, incorporates Digital Manufacturing Tools; Manufacturing Execution Systems tools; and Service Delivery and Field Information to capture, share and store in real-time data to determine how products and services are actually designed, made, and utilized. Linking these aspects of a product's life brings together research on manufacturing systems, CAD/CAM models, statistical methods for design, control, diagnostics of multistage manufacturing processes, analysis of warranty and service data applicable to manufacturing and lean healthcare. In doing so they aim to create a closed loop system which can lead to the development of methodologies for:

- Self-resilient production systems with the ability to self-recover from changes and faults in design, manufacturing and field-service phases.
- Co-evolution of products, processes and services in manufacturing and emerging healthcare systems.

Research in these domains involves modelling of products, production systems and service architecture analysis and causalities; design synthesis involving change reductions via Design-for-Six-Sigma; manufacturing systems design in early development phases; and optimization of distributed sensing networks. These are further applied to study manufacturing systems diagnostability and adjustability, convertibility, reusability, reconfigurability and scalability. Reductions for ramp-up time via Six-Sigma root cause analysis and process adjustment. Warranty/service failure reduction via root cause analysis for applications spanning manufacturing and healthcare sectors including engineering and data mining tools to support quality control, workflow and decision making at any life-cycle stage.

To find out more about this work go to: **go.warwick.ac.uk/wmg_dplm**

This research underpins the concept-to-creation philosophy of WMG, with a wide range of applications in digital manufacturing. For example, innovative approaches to new products from Professor Gordon Smith's research based on the combination of polymer processing and digital technologies.

To find out more about this work go to: **go.warwick.ac.uk/wmg_materials**

Informatics & Virtual Reality

The Informatics Group, led by Professor Vinesh Raja, has a mission to understand and extend the theory of data capture and extraction of information and wisdom with a particular focus in the engineering, manufacturing and healthcare sectors.

For more information on this work go to: **go.warwick.ac.uk/wmg_informatics**

Engineering informatics deals with customer requirements data and product lifecycle data; manufacturing informatics focuses on process data concerning factory design and layout, machining and assembly processes; whereas healthcare informatics is concerned with data for demographics, patient records, Picture Archiving and Communications Systems, remote healthcare monitoring, diagnosis, treatment planning and surgery planning.

Current research projects include:

- **I*PROMS:** flexible, re-configurable, fault-tolerant and eco- and user-friendly manufacturing systems that can react to customer needs, environmental requirements, design inputs, and material/process/labour availability to manufacture high quality, cost-effective products.
- **INTUITION:** virtual reality and virtual environments for future workspaces.
- **IWARD:** a robot swarm delivering support to oversee activities in healthcare environments, providing a multipurpose, cost-effective and scalable solution to enhance the quality of healthcare.
- **PhD projects:** modelling soft tissues for haptics applications such as virtual surgery; a virtual breast model for teaching breast examination to medical students and also for self examination by women; and developing a new rehabilitation environment for patients with upper limb impairments.

Applied Neuroimaging

The Digital Lab will house the world's first research-dedicated Applied Neuroimaging Centre, led by Professor Gemma Calvert. Neuroimaging involves the use of state-of-the-art imaging techniques such as functional magnetic resonance imaging (FMRI) and electroencephalography (EEG) to see inside the working human brain and observe neural activity in near real-time. These techniques are now being applied to better understand how consumers think, make decisions and experience the plethora of products, advertising messages and marketing media in the world around them.

For more information on this work go to: **go.warwick.ac.uk/wmg_neuroimaging**

Traditional market research techniques such as surveys or focus groups are limited in their ability to predict how people will behave in the marketplace. This is because much of our behaviour is driven by processes that operate below our awareness. Being able to tap into and understand how these unconscious cognitive computations operate can provide us with insight into consumer behaviour with considerably greater accuracy than existing techniques.

Some of the project areas that the Neuroimaging team at the Digital Lab will be particularly focusing on include:

- multisensory perception and product design
- neuro-economics
- measuring the efficacy of different advertising media
- neuro-marketing

Simulation & Modelling

The Simulation & Modelling team, led by Professor Rajat Roy, specialises in the design, analysis and re-engineering of manufacturing and service systems and business processes using computer models to capture and study system behaviour.

This process improvement work meant one partner improved its customer service level from about 80 per cent delivery within two weeks to nearly 100 per cent within a week, reduced manufacturing cycles from four weeks to one week and its inventory cost by about 50 per cent, enhanced productivity by approximately 20 per cent, and very substantially increased its turnover and return on sales.

The team has developed expertise in a range of other modelling tools and techniques to support R&D and to analyse and provide innovative solutions to improve the operational efficiency of partner organisations. Examples include the analysis, control and management of operational complexity arising from high levels of product variety and introducing concepts of mass customisation; analysis, characterisation and prediction of cosmetic surface defects in automotive body panels; development and implementation of a 200-user information model for the capture, re-use and effective communication of manufacturing process data; supporting a start-up company in the development of an intelligent web-based B2B service product for cost management.

In the Digital Lab, work will be focused under the broad themes of Digital Manufacturing (including the service sector) and Digital Healthcare (in collaboration with Warwick Medical School). On the latter, the aim is to support the UK Government's agenda on improving NHS service delivery processes.

WMG runs a Digital Manufacturing Management Masters degree that takes its cue from the research of the Simulation & Modelling team.

For more information on this work go to: **go.warwick.ac.uk/wmg_simulation**

Systems of Systems

In recent years the phenomenon of Systems of Systems has become recognised as a specific type of Complex System affecting many fields including biology, sociology, engineering and military where new systems are composed of a number of individual systems with their own levels of autonomy. There are several definitions of Systems of Systems but significant properties are autonomy of elements, evolutionary development, heterogeneous elements, sharing of resources, geographic distribution and emergent behaviour.

These properties, particularly that of emergent behaviour which is normally the undesirable result of unforeseen interactions, give the implementers of Systems of Systems challenges in ensuring their design is robust. There are also problems in validating such systems as the test space increases exponentially as the individual systems are linked together and it becomes more difficult to representatively test sub-parts in isolation.

Research led by Dr Peter Jones and Ross McMurran is developing new methods and tools for the robust design and validation of electronic and software-based Systems of Systems. This work is focussing initially on the automotive and intelligent transportation systems sectors but has applicability across other sectors.

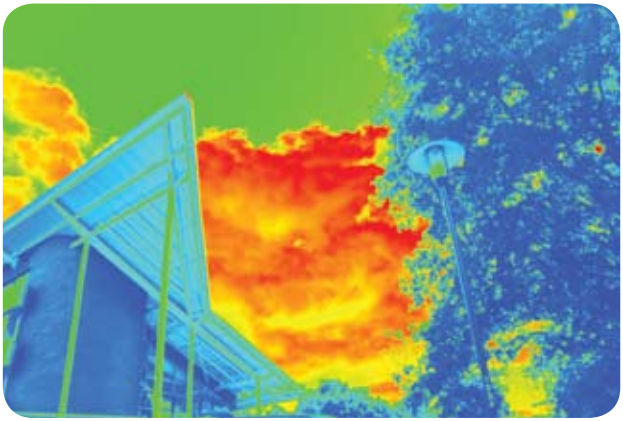
For more information on this work go to: **go.warwick.ac.uk/wmg_systems**

Key technical areas of this work are:

- The practical application of analytical design tools such as formal methods
- Design for robustness framework
- Model based testing
- Multi-domain modelling
- Extending Hardware-In-Loop testing
- Automated testing including automation at a human level for testing interactive systems including machine vision
- Robustness testing methods
- Data analysis methods for large data sets
- System Level Diagnostic techniques
- "Self-Healing" systems

Visualisation

The Visualisation team, led by Professor Alan Chalmers, is working to create "Real Virtuality": high fidelity virtual environments which provide the same perceptual response from viewers as if they were actually present, or "there" in the real scene being portrayed (also known as there-reality). A human's perception of the real world is more than just what we see, and thus real virtuality may need to include visual, aural, smell, touch and even taste, to achieve the appropriate level of perceptual realism.



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A high dynamic range photograph of the Digital Lab in false colour.

A key technical challenge in computing real virtuality is that of overall bandwidth to capture, store, transmit and deliver real world modalities to a virtual environment naturally and in real-time. In addition to investigating parallel rendering and novel high dynamic range (HDR) techniques to tackle real world lighting levels, the team is using knowledge of the way the senses interact to selectively render virtual environments; that is to direct computational resources to those areas of high perceptual importance while avoiding computing any detail which will not be perceived by the viewer. This can save substantial computation power.

Real virtuality has applications in many fields. Currently the Visualisation Group is investigating:

- healthcare
- product design
- architecture
- treatment of phobias
- cultural heritage
- serious gaming

More information on the team's work can be found at **go.warwick.ac.uk/wmg_visualisation** ■

The building of the Digital Lab

Brainchild of Professor Lord Kumar Bhattacharyya, construction on the Digital Lab began in spring 2007, less than two years after he first floated the idea.

Lord Bhattacharyya said: "The future is digital, that's obvious. WMG has always been at the forefront of technological developments and this is no different. The work we'll do here will be second-to-none."

The specification for the £13 million building was exacting. The four-storey structure is designed around a central first floor concourse. Here, staff, students and visitors can gather and talk in bespoke informal meeting areas.

In designing the Digital Laboratory adaptability was a key requirement. It will be possible to reconfigure rooms easily without major disturbance to the building.

Facilities within the building include: research labs, visualisation and demonstration rooms, meeting rooms, open-plan office accommodation, presentation rooms and a lecture theatre with state of the art audio visual systems.

Not only that, the University aims to achieve BREEAM Excellent rating for the high environmental standards contained in the building including: natural ventilation system; sedum roof; extensive use of natural light; and natural landscaping, coupled with a considerate approach to construction.

The building is situated next to WMG's headquarters at the International Manufacturing Centre.

Advantage West Midlands

CSWP Ltd

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